

## Intellect in Brutes

IN answer to the objections raised by W. P. Buchan and Henry Muirhead to the case of rats gnawing water-pipes for the express purpose of obtaining water, as described in my letter to NATURE, vol. xix. p. 365, I propose to give particulars of the situation of the pipes so gnawed in two instances. No. I. At Poplar. Pipe laid on second floor, between flooring-boards above and ceiling below, between joists the usual distance apart; plenty of room all round pipes to obtain access to any part of the floor, also rat-holes in woodwork to facilitate communication. As the pipe lay above the ceiling of the floor below, there was no necessity to attack the pipe in order to get through that ceiling—if that were desired. A hole could easily have been made at any point on either side of the pipe. The upper floor was a corn loft, and it is inferred from the circumstances, that the rats, feeding upon this very dry food, had tapped the water-pipe to obtain a supply of water close at hand. No. II. On Haverstock Hill. Cistern in scullery about six feet from the floor, pipe (lead), comes thence down wall, passes under floor of scullery to kitchen to supply kitchen boiler. Pipe laid on the earth, between joists, raised, of course, on bricks. Pipe gnawed on upper side. Plenty of room all round for rats to pass freely under all parts of the floor, as any practical builder will readily understand. They could have tunnelled under this  $\frac{3}{4}$ -inch pipe from either side through the soft earth. Of the two holes in the pipe one will admit a small pin, the other is about  $\frac{1}{8}$ th of an inch in greatest diameter, and about an inch from the first. These are transverse perforations, the ineffectual attempts are in a longitudinal direction. It is of course quite possible, as in Mr. Buchan's cases, that rats occasionally find gas-pipes in their way and are compelled to attack them, but I do not think any of your readers will imagine that his question, "Now, are they cut to get at the gas?" needs a moment's consideration. Possibly some of your correspondents may be able to corroborate the following—A ship's carpenter told me that, in the old days before the use of iron tanks on board ship became general, the rats used to attack the water-casks, cutting the stave so thin that they could suck the water through the wood, without actually making a hole in it. If any one could substantiate this it would have an important bearing on the question under consideration.

ARTHUR NICOLS

I AM glad my remarks have elicited others, for I want to have my difficulty solved, which I will put thus:—Why is it that no dog ever (to my knowledge, of course) observed a person ring a bell, noticed that the bell brought the servant, and then went through the process of reasoning—"Because such was the result I will ring the bell too"? This I call abstract reasoning. On the other hand, why is it at all necessary to teach the dog to ring the bell? for it is not necessary to teach a boy. Boys do acquire sooner or later abstract reasoning, but it is with them practically a feeble power, as I have shown, and with rustics it seems, sometimes, to be totally in abeyance, as the following illustration will show. An entertainment was given to some hundred labourers and their wives, and a Mr. Cross told them to spend the afternoon in a field, but hoped none of them would be his name. Not one understood him, or could go through the simple process of reasoning—"We are not to be his name, his name is Cross, therefore we are not to be cross." It is this *mental reflection* which seems to me to be wanting in animals; thus, monkeys will warm themselves by a fire of burning sticks, but do not seem capable of thinking—"Because sticks burn, therefore, if I put more sticks on the fire I shall get more warmth." I should be extremely glad to hear of any cases of such purely *abstract mental reflection* in animals, for at present, there seems to me to be a hiatus here.

GEORGE HENSLOW

## On the Freezing of Lakes

WE wish to draw your attention to a statement contained in an article under the above heading which appeared in NATURE last week, p. 412.

The author, Mr. J. Y. Buchanan, says:—

"Most of the observations were made with one of Negretti and Zambra's 'half turn' deep-sea thermometers, which proved a useful instrument for this species of inquiry. It was necessary, however, to fit it with a suitable inverting contrivance, as the apparatus supplied for this purpose by the makers is quite useless."

Fortunately this thermometer and apparatus has now been in use for some time, and its performance fully tested by persons whose opinion is of the highest value. We can only say that had Mr. Buchanan used the apparatus according to our printed direction, viz., lowered the instrument to the required depth, let it remain a few seconds, and then pulled it up as fast as practicable and without stopping, he would not have failed to have obtained correct results. We cannot possibly imagine how he could have failed; had we not ourselves tried the inverting apparatus in every possible way, and had we not received the highest testimony as to its efficiency, we would have remained silent, but as it is, and knowing we have invented as good an instrument as has ever been contrived for the purpose, we cannot allow the statement to pass unchallenged that we have supplied a useless apparatus. If Mr. Buchanan could not obtain satisfactory results with our apparatus it must only have been because he did not use it as we directed.

HY. NEGRETTI AND ZAMBRA

## THE MIGRATION OF BIRDS

MORE than four years ago an article, headed as above, appeared in this journal (vol. x. p. 415) giving rise to some comments of more or less importance (*tom. cit.*, pp. 459, 520, and xi. p. 5). Since that time two very remarkable treatises on the subject have come forth, the one by Dr. Palmén, on the routes taken by birds in their migrations, and the other by Dr. August Weissmann, dealing generally with the whole question.<sup>1</sup> The first, originally published in Swedish,<sup>2</sup> was translated into German soon after, and in due time was reviewed in these columns (vol. xv. p. 465). An excellent English version of the second has recently appeared in the "Contemporary Review" (February, 1879, p. 531), and therefore my readers may be presumed to be acquainted with the views of both authors. It cannot be denied that each of them has to some extent enlarged the boundaries of our knowledge of the subject, and still more widely those of our speculations upon it.

As regards Dr. Palmén's work, the opinion held by his reviewer in these columns as to the assignment of routes to the migratory birds of North-Western Europe being "purely conjectural" is one that I wholly accept. I should even be inclined to go further, and say that it might be called rash, as it is evident that no such observations as would justify its adoption exist. Still I concur with the reviewer in that I would not at present term it entirely erroneous, though I venture to express my entire disbelief in the route "X." This is supposed by Dr. Palmén to start from Greenland and Iceland, and to pass by the Færoes to the Hebrides, when, after coalescing for a short distance with one or more lines from the north-east, it either loses itself on the West Coast of Ireland, or, running down St. George's Channel, skirts Scilly and crosses to the shores of the Bay of Biscay. Space forbids my entering into details which would show, I think, that this route is altogether imaginary. I will only say that what we know of the movements of two very characteristic summer visitants to Iceland, *Motacilla alba* and *Limosa algocephala*, points to that conclusion, and I would leave it for Irish ornithological observers to prove whether Dr. Palmén is right or not.

Dr. Weissmann, happily for him, has no such compunction. He fully accepts Dr. Palmén's conjectures as absolute truths. Suppose, however, we assume them to be established—and there seems no reason why further observation should not establish most of them—they would show in Dr. Weissmann's opinion that the migrating birds of to-day in crossing the sea follow what once were "land-bridges" (*Landbrücken*), that is, isthmuses of dry land separating seas or oceans under which they are now submerged. The existence of such former terrestrial communications between continent and con-

<sup>1</sup> Sammlung gemeinständlicher wissenschaftlicher Vorträge. XIII. Serie Heft 291. "Ueber das Wandern der Vögel." Berlin, 1878.

<sup>2</sup> Om Foglarnes flyttningvägar. Helsingfors, 1874.

continent, at the present time revealed to us by shallow soundings and some mountain-peaks changed into islands, may be indubitable. I, at least, in regard to Europe and Africa do not question it, and it may be true all the world over. But this same hypothesis has been more or less hinted, if not absolutely promulgated, by Prof. Baird (*American Journal of Science and Arts*, May, 1866) and Capt Hutton (*Trans. N. Zealand Inst.*, v. p. 235). So far, then, there is nothing novel in the Doctor's views.

In like manner Dr. Weissmann seems to me to have been anticipated by Capt. Hutton (*ut supra*) and by Mr. Wallace (*NATURE*, vol. x. p. 459) in his explanation of why birds migrate at all. The only material difference between the last of these authors and the Doctor is that, while Mr. Wallace most rightly (as it seems to me) regards migration as originating with the bird at its breeding-quarters, Dr. Weissmann considers it to begin with the bird in its winter retreat. Perhaps this does not much matter, but it is as well not to put the cart before the horse if you want to prosper in your journey, and so long as lack of food be admittedly the strongest incentive to migration, it seems preferable to look on migration as beginning where that incentive is strongest. This, it scarcely needs to be said, is when, towards the close of summer, the supply of food grows scarce.

However, the most important part of the whole business is the question how the birds find their way to the places whither they repair, whether for the purpose of breeding or for that of procuring sufficient sustenance. Dr. Palmén regards it simply as a matter of "experience," and Dr. Weissmann hardly differs from him. It is "practice" (*Uebung*), says the latter—not indeed the practice acquired by the single bird, but the practice acquired by the whole species. "This faculty (*Virtusität*) of finding the way has not arisen suddenly, but most gradually, in the course of many thousands of generations." Now with all my faith in the marvellous results which are doubtless produced by the hereditary transmission of certain qualities, I think some caution is needed before we accept "practice" as the true explanation of the puzzle. Dr. Weissmann says that he does not see what more is needed than a fine power of observation and a keen eye to take in every thing of importance for a knowledge of the way, and then a very remarkable memory for places by means of which all details of the long route shall be retained. The knowledge of direction (*Orientierung*) will then follow of course. Subsequently he takes the instance of a woodpecker being able to find the tree containing its nest, though surrounded by hundreds of similar trees, and declares that this knowledge or sense of direction must, in the case of birds when migrating, be wholly analogous. He suggests also that the height at which birds sometimes fly, referring apparently to a remark by Mr. Tennant (*NATURE*, xiii. p. 447), would enable them to cross the Mediterranean, and seldom or never lose sight of land.

This may be; but migration goes on in other parts of the world, and a good explanation ought to apply elsewhere. Will Dr. Weissmann's hold good for our Antipodes? In regard to New Zealand Capt. Hutton has remarked (*Trans. N.Z. Inst.*, v. p. 235):—"That we should have two cuckoos which migrate regularly to other countries, each more than a thousand miles distant, is a fact that deserves special attention, for I know of no parallel case in any other part of the world, the distance across the Mediterranean being less than half that travelled over by our summer visitors." These two cuckoos are *Chrysococcyx lucidus* and *Eudynamis taitensis*, the former, it is supposed, making its annual journeys to and from Australia,<sup>1</sup> and the latter to and from the Friendly Islands or the Fijis, it being found in both groups, to say nothing of other places further off. Let us consider the case of the *Eudynamis*. Due north of New Zealand there appears

<sup>1</sup> I should rather suspect to and from New Caledonia.

to be no land until Fiji is reached, but a little to the westward of the direct line lies Norfolk Island and its companions, and about as far to the eastward are the Kermadecs. Of these, the most southerly is 450 miles from New Zealand, and the most northerly about the same distance from Pylstaart, an outlier of the Friendly Islands. The *Eudynamis* starting from New Zealand for the northward would have nothing to supplement its inherited "sense of direction" save the landmarks offered to the right and left by the Kermadecs and Norfolk Island respectively. To see the former it would have to mount to the height of some twenty miles,<sup>1</sup> and to again mount about as high on leaving the Kermadecs on its way to Pylstaart. It might be urged that the bird having by "practice" a sense of the direction in which it ought to go, might fly half the distance, keeping the land of departure in sight—though, considering the position of birds' eyes, this would not be easy—and then, without exceeding the level of six or seven miles, it might behold the Kermadecs, but even this is an elevation far beyond Dr. Weissmann's 20,000 feet. The route by Norfolk Island being longer, need not here be discussed.

It is much to be desired that something positive were known as to the height at which it may be possible for birds to perform their passages, but on this point we have (so far as I am aware) little information. The experiments made by Mr. Glaisher on the six pigeons taken up in his celebrated balloon ascent, September 5, 1862 ("Rep. Brit. Ass.," 1862, p. 385), unfortunately admit of no definite deductions. One pigeon thrown out at the height of three miles "extended its wings and dropped as a piece of paper." A second at four miles "flew vigorously round and round, apparently taking a dip each time." A third between four and five miles "fell downwards as a stone." A fourth at four miles, in the descent, "flew in a circle," and then alighted on the balloon. The two remaining pigeons were brought down, and one was found to be dead! Perhaps a little more "practice" or "experience" was wanted, but at any rate the results do not seem to favour the notion that birds can fly comfortably at those heights. Nor is this surprising, considering the well-known effects of the rarification of the air at great heights. I of course pretend to no special knowledge of this subject, but Mr. J. W. L. Glaisher, F.R.S., kindly informs me that at an elevation of five miles the density of the air is about  $\frac{1}{2.7}$  of what it is on the earth's surface, at an elevation of

seven miles about  $\frac{1}{4.1}$ , and of ten miles about  $\frac{1}{7.5}$ . I know not whether experiments have been made to test the endurance of a bird's life under such a condition as the last, but it could of course be easily produced under an air-pump. It would not be so easy to test the power of flight under the same condition. It is only obvious that the power would be very greatly diminished, and I should be glad to learn the results of any investigation of this kind. Physicists and physiologists might here give ornithologists great help.

But to return to the question of distance and sight. How comes it that the American Golden Plover (*Charadrius virginicus*) passes regularly every year in large flocks over the Bermudas, 600 miles from the nearest point of land, and that a point whence these flocks certainly do not take their departure. If the islands are "still vext" by stormy weather, the flocks alight and afford the inhabitants a good deal of sport. If the weather be fine, the flocks seem to continue their southward course. Nor is this plover the only regular visitant. The American Night-Hawk (*Chordeiles popetue*) is as constant in its appearance at spring and fall, and so are

<sup>1</sup> Of course the exact height would depend on the elevation of the land, concerning which I have no information.



more species of *Limicola*, and perhaps of other groups, than I can here name. Is it to be supposed that all these birds, some of them flying by night, make Bermuda by the means which Dr. Weissmann considers sufficient? If his explanation is good it must be good for New Zealand and Bermuda, as well as for the Mediterranean. But there is yet a stronger case to be cited. The Sandwich Islands, as I have learned on authority I cannot doubt (though I know not any mention of the fact in print), are yearly visited like Bermuda, but with even greater punctuality, by large flocks of Golden Plovers—whether *C. virginicus* or *C. fulvus*, is undetermined, but that does not much matter. If the birds belong to the first of these forms they must come from the west coast of America, if to the second from the east coast of Asia. Now there is no land between the Sandwich Islands and the Californian or the British-Columbian coast, but between them and the Aleutians, as I learn from Mr. Rye, there is one islet, Roca de Plata or Crespo. This, however, does not lie in a straight line, and is some 720 miles north-west of the Sandwich Islands, and 1,200 south-west of the Aleutians. Running generally westward of the Sandwich Islands is a series of islets, at distances, perhaps, not exceeding 150 miles, which no doubt might serve as guide-posts for the plovers did they but make for them, but the series comes to an end in about long. 178° W., and though by turning suddenly to the north-east from Morell Island towards Mellish Bank (300 miles), the Aleutians again appear as the nearest land in a northerly direction, the distance of 1,020 miles has to be covered! On the supposition that the birds are of Asiatic birth, and therefore come by another course, we find that due west of Morell Island is Ganges Island, but that is 930 miles off, and thence to reach the easternmost of the Japanese group is 690 miles further! Thus, whichever form of golden plover it be that visits the Sandwich Islands, its regular advent there needs, I think, some fuller explanation than that afforded by Dr. Weissmann's theory.

Then again, there is another set of facts which seem to me irreconcilable with the theory of mere "practice" or "experience." It must be remembered that though Dr. Weissmann relies most on the inherited practice of the species, still he does not neglect the individual, and both he and Dr. Palmén make considerable use of the observation that adults, and male adults in particular, lead the migratory flocks. This fact, so far as I am aware, has only been noticed in the northward movement in spring, and elsewhere I have endeavoured to account for it ("Encycl. Brit.," ed. 9, iii. p. 767). In autumn it may be doubted whether there is anything of the kind, and we have in many species, the young of the year—birds that are but three months old, or even less, migrating southward with the greatest regularity unaccompanied by adults. This seems to happen with nearly all the *Acipitres*, nearly all the *Limicolæ*, and perhaps, some others, that are bred in arctic or sub-arctic districts. It happens also with our own Cuckoo (*Cuculus canorus*), and this case is still more wonderful, for the young Cuckoo has had no communication whatever with its progenitors (who have already taken their departure from our shores some weeks earlier), and its foster-parents with us are generally species which do not migrate to any great extent—the Hedge-Sparrow (*Accentor modularis*), Titlark (*Anthus pratensis*), and Pied Wagtail (*Motacilla lugubris*). Yet our young Cuckoos, starting alone and travelling over utterly unknown country, must, on the whole, successfully reach their destination, or the breed would become extinct here.<sup>1</sup> Dr. Weissmann may indeed well say of migrating birds, that the young,

when it cracks the shell, possesses "great geographical talent"!

I might easily prolong this article, for there is much more to be said on the subject, and in some details, by no means unimportant, Dr. Weissmann seems to have fallen into errors that I have not here noticed, but my chief object in making these remarks has been to hinder persons who have not previously thought on the matter from taking his easy explanation of the mystery of ornithological mysteries to be sufficient. Believing, as I once before said, that its solution is probably simple in the extreme, and having a strong faith in the hereditary transmission and accumulation of faculties so as to become a wonder-working power, I yet cannot think that he has succeeded in making known the secret and in satisfactorily explaining how birds cross "the sacred spaces of the sea."

ALFRED NEWTON

#### THE DIMENSIONAL PROPERTIES OF MATTER IN THE GASEOUS STATE

BY assuming a sufficient number of sufficiently insignificant individuals to constitute a group, it is possible to imagine a state of things in which as far as it can be observed from a certain distance, all evidence of individual action is entirely lost. In this way has been framed the molecular hypothesis or kinetic theory of gas. But it must be obvious to every one who has considered this molecular hypothesis, that the apparent uniformity in the actions we perceive must be the result of the distance (so to speak) from which these actions are observed, and that could we sufficiently localise (as regards time and space) our observation, we must perceive in all their varieties the individual actions of the molecules. And even failing this, between the actions of the individuals and the absolute mean action there must be local or parochial actions which would be distinguishable at greater distances than the purely individual actions.

In order that the properties of a gas may appear perfectly uniform in all directions and quite independent of the shape and volume of the space which the gas is constrained to occupy, the number of molecules must be countless, and the temporary action of each individual must be confined to an imperceptibly small portion of the space observed. If these conditions are not fulfilled then the properties of the gas will not be uniform, and we must have dimensional properties depending on the dimensions of the constraining surfaces.

The idea of our being able actually to perceive such properties does not appear to have been entertained hitherto. Until fifty years ago, all the mechanical properties of gases were regarded as quite uniform, the only mechanical distinction between one kind of gas and another being that of weight. Since that time in the phenomena of diffusion, and the phenomena attending the passage of gases through minute channels, properties of gases have been recognised which readily distinguish between one kind of gas and another, and even more than this, for Graham found that there was a difference in the relative behaviour of different gases in differing through porous plates of different coarseness. Still, neither Graham nor any one else appears to have recognised evidence of dimensional properties.

Neither did the development of the mathematical theory lead to the revelation of dimensional properties. Since 1864 it has been known that this theory included the explanation of all the uniform properties of gas. But in developing this theory attention appears to have been paid exclusively to the mean of the motions. And although Prof. Maxwell points out that there must ultimately be dimensional properties, he has not pursued the investigation, so as to reveal their character.

In 1874 a very remarkable phenomenon was brought to light by the experiments of Mr. Crookes—that in ex-

<sup>1</sup> Since I wrote this I have heard from Mr. Gätke, so well known for his observations on migratory birds, that young Starlings pass over Heligoland during July by hundreds of thousands, "without a single old bird accompanying them," while the old birds begin to migrate at the end of September and continue for the next two months.